ores, Prof. A. P. Coleman with copper and nickel, Mr. J. B. Tyrrell with placer mining, and Prof. T. L. Waller with the rare metals. Prof. Miller prefaced his description of the gold and silver mining with a general account of mining in Canada. He pointed out that, until a few years ago, the central part of Canada was regarded as purely agricultural. The discovery of the rich ore deposits of Sudbury and Cobalt in 1908 completely changed this, and the value of the mineral produce rose from about a million dollars in 1901 to eighty-seven million dollars in 1908. The most interesting feature of the mineral wealth of Canada is its great variety. Canada is now the largest producer in the world of nickel, cobalt, asbestos, and corundum. As regards the immediate subject of his paper, Prof. Miller stated that the output of gold from the Archæan districts was not great, but it was found in British Columbia and the Yukon, the latter district standing third in the world's output. Gold is found also in Nova Scotia, and has recently been discovered at Prince Albert, in Saskatchewan. The great silver-producing region is Cobalt. The Canadian production of iron is as yet comparatively unimportant.

Prof. Coleman pointed out that copper is found in many parts of Cañada, and in British Columbia some very low-grade ores are worked to a profit. Most of the copper of Ontario is found associated with nickel, the great locality for these substances being Sudbury, where the deposits occur in the marginal portion of a laccolitic mass of norite intruded between the Upper Huronian and the Animikie.

In dealing with placer mining, Mr. J. B. Tyrrell pointed out that it was almost confined to the mountainous region of the west, and that the industry had gradually spread along the river valleys from California northwards until eventually the Klondyke deposits were met with. These owed their value rather to exceptional conditions of erosion than to special richness. Mr. Tyrrell estimated that the Yukon district had yielded hitherto about six million ounces of gold, and might yield another four million.

Prof. T. L. Waller concluded the series of papers on the mineral resources of Canada with a description of the rare metals. Platinum and palladium are found in small quantities in the native state in placer workings at various points. Platinum has also been found combined with arsenic in the decomposed superficial deposits of the Sudbury district. Canada is also rich in undeveloped deposits of molybdenum and tungsten.

(4) *Palaeontology and other Subjects.*

In addition to the president's masterly address on the evolution of vertebrate life as shown by fossils, vertebrate palæontology was represented by two short papers, also by the president, recording the discovery of dinosaurian remains in the Cretaceous rocks of Australia and the Trias of Brazil, and by the report of the committee appointed to investigate the footprints of the Trias of Great Britain.

Other papers read before the section were by Mr. E. Dixon, on unconformities on limestone and their contemporaneous pipes and swallow-holes; by Prof. E. F. Chandler, on the rainfall run-off ratio in the prairies of Central North America; and by Dr. Tempest Anderson, on the volcano of Metavanu, in the Samoa Islands. The eruptive phenomena of this volcano closely resemble those of Kilauea, in the Sandwich Islands; but while the latter volcano, according to Dr. Anderson, is in its old age, the former shows the same phenomena with the exuberance of youth. A further interesting point in Dr. Anderson's paper was his confirmation by actual observation of the subaqueous production of the "pillow" structure in lavas.

The reports of the following committees were also presented:—on South African strata, by Prof. J. W. Gregory; on topographical and geological terms in South Africa; on geological photographs, this taking the form of an exhibition of lantern-slides illustrating certain aspects of British scenery; on the crystalline rocks of Anglesey; on the composition of the Charnwood rocks; on further excavations on Neolithic sites in north Greece; and on the salt lakes of Biskra. This latter report, which was represented merely by the title, refers to the work upon which the late recorder of Section C, Mr. Joseph Lomas, was engaged at the time of his lamented death.

ENGINEERING AT THE BRITISH ASSOCIATION.

THE proceedings in Section G consisted largely of papers by Canadian engineers on a closely related group of subjects, determined by the conditions of Winnipeg. Winnipeg occupies a peculiar geographical position, similar in some respects to Singapore or Buenos Ayres, as the gate of a great productive area. This position, and the bearing on it of the communications to the section, are most easily explained by recalling the geography of the country. Canada consists roughly of five sections.

(1) The Laurentian area, the so-called shield of Canada, is defined by the St. Lawrence and the chain of lakes which extends through Winnipeg, Athabasca, and the Great Slave and Bear Lakes to the polar regions. This vast district lying round Hudson's Bay is in the main a wilderness of lakes, rocks, and forests, swept clean of all cultivable soil by Glacial ice, except in certain areas where later Palæozoic rocks have been left over the Laurentian.

(2) The rich agricultural country between the Laurentian area and the Rocky Mountains. This, the modern provinces of Manitoba, Saskatchewan, and Alberta, is the northern section, reaching to 60° N. lat., of that geographical area of which the southern section is the basin of the Mississippi.

(3) The mountain region between the eastern foothills of the Rockies and the Pacific, a strip 400 miles wide extending up the whole coast.

(4) The fertile lands along the south of the St. Lawrence, New Brunswick, Nova Scotia, and the peninsula between Erie and Huron.

(5) The Arctic regions of tundra and ice.

To these five sections must be added for administrative purposes another of equal importance.

(6) The navigable route of St. Lawrence and the lakes.

Winnipeg is the gate between (2) and (6).

This section (2), 1200 miles long from north-west to south-east, and from 300 to 500 miles wide, is of extraordinary fertility, and especially adapted for growing wheat. The isothermals take a strong bend upwards in this region, and wheat has been ripened as far north as the Great Slave Lake, in 62° N. lat. The fertility of the soil is such that wheat can be grown remuneratively for many years in succession, and where the practice has obtained of allowing the land to be fallow one year in four to prevent exhaustion, it has to be sparsely tilled in the seasons following the fallow years to prevent the crops choking themselves by their own exuberance. Of this area, only 5 per cent. is yet cultivated, but in 1908 this produced 30 million quarters of grain, and carried nearly 4 million head of stock.

So long as the United States grows enough wheat for her own consumption, and until a new route is opened to the Atlantic by the Nelson or Churchill rivers on Hudson's Bay, the main trade of the provinces must pass east between Lake Winnipeg and Lake of the Woods. Here on the Red River, where the fertile lands end and the Laurentian wilderness begins, is Winnipeg, on the site of an old Hudson Bay Co.'s fort, Upper Fort Garry. A better site would have been at Selkirk or Lower Fort Garry, lower down the river and nearer the lake, but the site of the great depôt was ultimately fixed by the Canadian Pacific Railway for indirect reasons.

The great engineering questions of the city are to find the best means to develop the agricultural industry of the north-west, and to improve the trade routes, especially to the Atlantic. The papers presented to the Engineering Section dealt largely with these two subjects. Two papers on the grain industry, each of considerable length, were contributed by Mr. John Miller, an official at the experimental farm at Indian Head, Saskatchewan, and by Mr. George Harcourt, Deputy Minister of Agriculture of the Province of Alberta. The latter of these, especially, was a paper of exceptional ability and interest, the author being intimately acquainted with his subject and an admirable lecturer. He exhibited a map showing some of the extreme points in which wheat has been successfully ripened, and the area of potential grain-growing country. The subjects of these papers were not strictly those of engineers, but the urgent need for improved communications with which other papers dealt could hardly have been realised without them. These other papers fell into two groups, viz. deep water and railway communications. The problems of wheat transport are (1) to bring ocean steamers to the nearest possible point to the wheat fields, and (2) to handle and transport the grain to the ports as efficiently as possible. At present ocean-going steamers drawing not more than 27½ feet of water can reach Montreal at all tides, and this depth is being increased to 30 feet. Ships drawing 14 feet of water can pass between Montreal and Lake Erie by the lower Ottawa river, the Lachine and Rideau canals, Lake Ontario, and the Welland canal. Erie, Huron, Michigan, and Superior can be navigated by vessels drawing 20 feet of water, the depth of water in the Soo locks. If the depth of water in the lower Ottawa river, and in the Lachine, Rideau, and Welland canals, in all of which the depth is now 14 feet, could be increased to 22 feet, ocean steamers of, say, 7000 tons, by taking in or discharging the last 1000 tons at Montreal, could reach Lake Superior and charge or discharge cargo at Port Arthur, the nearest point to Winnipeg. Thus, subject to a small proportion being transhipped at Montreal, cargoes could be carried in bulk by ocean steamers of the size of ordinary tramps between Port Arthur, in the very heart of the continent, and any Atlantic port.

This route, however, is open to serious objection in that it lies through the Detroit River, and is liable to interruption by political difficulties with the United States. A new canal route which is not subject to this objection has been surveyed. The scheme, which is called the Georgian Bay Canal Scheme, provides for a canal between Montreal and Lake Superior by way of the Ottawa River, Lake Nipissing, and the Pickerel and French rivers, having a minimum depth of 22 feet and locks 650 feet long, at a cost of 20 millions sterling. This canal would accommodate ships of the type now used to carry ore and coal between Cleveland and Lake Superior, as well as ordinary ocean-going tramp steamers. As a set-off to the cost, the water-powers that would become available are put at one million horse-power, and the value of the country that would be opened up would be very large. It seems probable that the work will be started before long.

On this side of the subject three considerable papers were read. Colonel Anderson described the navigation works on the St. Lawrence up to Montreal, and showed maps of all the lights and buoys, and of the dredging accomplished and still to be done. Mr. St. Laurent placed in the president's hands copies of the Government reports and plans of the Georgian Bay Canal surveys, and the latter read a paper to the section on the subject. In addition, Major George Stephens contributed an admirable paper on the St. Lawrence River as an imperial highway, and on the importance of Montreal as a central port of distribution.

The Hudson Bay route is not likely to be developed in the immediate future, and little reference was made to it. The Canadian Northern Railway has surveyed a route to Churchill, on the Hudson Bay, though the mouth of the Nelson may ultimately be preferred, as it is said that this river, draining lands far to the south, even beyond the U.S. frontier, is very free from shore ice. In the future Canadians look to the Nelson River being made navigable up to Lake Winnipeg, and from there the Saskatchewan may carry ships to the foothills of the Rockies.

Mr. T. E. Schwitzer, assistant chief engineer of the Canadian Pacific Railway, contributed a paper on some important works on that railway. The Lethbridge Viaduct is an immense structure, more than a mile long and more than 300 feet high, and the mode of construction was strikingly bold and effective. The revision of the grades in Kicking Horse Pass, involving the construction of two long spiral tunnels in the rock, was also described, and the great increase obtained in the loads hauled by a given engine-power. Careful grading on lines where the heavy loads of grain and other material usual in Canada are hauled is of extreme importance, and much was said on the cost of rail transport both in this paper and in two others by Mr. Macpherson and Mr. Lanigan. Mr. Duncan Macpherson described the organisation of the surveying parties for the new line between Monckton and Winnipeg, to be continued to the Pacific coast as the Grand Trunk Pacific. It is this line which is interrupted near Quebec by the failure of the great cantilever bridge while under construction. Mr. H. W. Lanigan wrote on the organisation for the collection and transport of grain in the wheat area. As assistant manager of freight traffic on the Canadian Pacific Railway at Winnipeg he has an intimate knowledge of that subject. The policy of the Canadian Government is to forbid the owners of elevators to trade in wheat and to restrict them to the duties of collecting and despatching, much as railways are restricted to the work of carriers. The Government undertakes the inspection and grading of the wheat, and performs this work with extreme care, so that the wheat is sold by the farmer and bought by the ultimate purchaser strictly by grade, not by sample. That is to say, the quality of the wheat having been determined by the Government inspector, the price paid per bushel is the current price for that quality. The system is too complex for more than reference here, but the advantage both to farmer and purchaser of an authoritative determination of quality is obvious.

Besides the papers we have referred to, which are all mainly of Canadian interest, three electrical papers were contributed by Prof. Marchant, Prof. Thornton, and Mr. E. A. Watson respectively, all dealing with three-phase transmission lines. Other papers were by Sir John Thornycroft, on skimming boats; by Colonel Ruttan, the city engineer of Winnipeg, on the high-pressure water plant of the city; by Mr. C. B. Smith, on a new hydro-electric power plant now being erected by the city authorities; by Mr. C. E. Larard, on torsional tests on materials—a very elaborate and detailed paper; by Prof. Coker, on an optical method of exhibiting strain; by Mr. Dugald Clerk, on the work of the gaseous explosions committee; and by Prof. Foster, on a systematic examination of the properties of the different coals of Canada now being carried out at McGill University. We have left to the last a paper on the Panama Canal by Colonel Goethals and Sir William White's address. Colonel Goethals is engineer-in-chief and president of the Isthmian Canal Commission. The paper was a long one, and very fully illustrated by lantern-slides. Colonel Goethals himself was unable to come to Winnipeg to deliver it, but Lieut. Goethals, of the United States Army, who has been engaged on the canal under his father, gave an account of it and exhibited the illustrations. It will be remembered that the failure of the French operations was largely due to two causes, one of which was the excessive mortality among the labourers and staff from tropical fevers, and the other the violent floods of the Chagres river. Since that time the cause of tropical fevers has been traced to the mosquito, and the American engineers, with characteristic thoroughness, have extirpated the mosquito over the whole of the canal zone, thereby bringing the rate of mortality to the figure of a well-organised town in a temperate climate. The measures which have enabled them to do this are of extraordinary interest, and the results are almost romantic. The engineering difficulties, which were mainly the floods of the Chagres, mentioned above, and the enormous excavation of the Culebra ridge, have been met by a design which promises to be quite successful. The Culebra ridge is much nearer to the Pacific than to the Atlantic shore, and deep valleys run down from the divide to the Caribbean Sea, one of which carries the Chagres river. Across this an immense earthwork dam, the Gatun dam, is being constructed, forming a great lake 160 square miles in area in the centre of the isthmus. The floods of the Chagres and of the other rivers, its tributaries, flowing down these mountain valleys, can discharge themselves into this large body of water without doing any damage to the canal works, however violent the floods may be. The level of the water in the lake is regulated by a spillway, built in a natural hill which forms part of the Gatun dam, discharging below the dam into the old bed of the Chagres. The surface of the lake is 85 feet above the mean sea-level, and is reached by three locks on each side. The lake is amply sufficient to provide the necessary water for lockage and waste during the dry seasons. Lastly, this high summit-level has reduced very largely the necessary amount of excavation in the Culebra cut. Even then, however, this amounted to 150 million cubic yards. Besides photographic views of the works and machinery, there were exhibited copies of some of the working plans and surveys, and it is much to be hoped that the whole paper may be published in full. A recommendation to this effect was made by the committee.

Sir William White was expected to deal in his presidential address with problems of naval organisation and construction, peculiarly interesting at a time when the Imperial Naval Conference was sitting in London. His address was, however, an admirable preface to the series of papers on questions of water and railway transport which followed it, and was a masterly review of the position of Canadian commerce.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Prof. Jordan Lloyd has accepted the invitation of the council to succeed Prof. Bennett May in the chair of surgery.

Prof. Peter Thompson, of King's College, London, has been appointed professor of anatomy in the place of Prof. Arthur Robinson.

The chair of zoology, rendered vacant by the death of Prof. T. W. Bridge, F.R.S., has been filled by the election of Dr. Frederick William Gamble, F.R.S.

The following appointments have been also made:—Dr. Jessie S. Bayliss, as lecturer in botany; Messrs. F. W. Aston and H. B. Keene, as demonstrators in physics; Mr. T. F. Wall, as assistant lecturer and demonstrator in electrical engineering; and Mr. Cyril S. Fox, as demonstrator in coal mining and lecturer in mine surveying.

CAMBRIDGE.—The professorship of zoology and comparative anatomy is vacant by the resignation of Prof. Sedgwick. The electors will meet for the purpose of electing a professor on Friday, October 29. Candidates are requested to send in their names to the Vice-Chancellor on or before October 22.

Notice is given that the Quick professorship of biology is vacant, as the period of three years for which Dr. Nuttall was appointed has now ended. The election will take place on Friday, October 29. Candidates are requested to send in their applications to the Vice-Chancellor on or before Friday, October 22.

Mr. F. A. Potts, of Trinity Hall, has been appointed demonstrator of comparative anatomy for one year from Michaelmas, 1909. Mr. L. A. Borradaile, of Selwyn College, has been appointed demonstrator of animal morphology for one year from Michaelmas, 1909. Mr. F. T. Brooks, of Emmanuel College, has been appointed senior demonstrator of botany for two years ending September 30, 1911, and Mr. D. Thoday, of Trinity College, has been appointed junior demonstrator of botany for the same period.

An anonymous benefactor has promised the sum of 100*l.* towards the construction of a field laboratory in the vicinity of Cambridge, in connection with the Quick Biological Laboratory. The sum of 100*l.* has been granted by the advisory committee of the tropical diseases research fund towards the expenses of the Quick Laboratory in the present year.

GLASGOW.—The University is to benefit to the extent of 10,000*l.* from the estate of the late Dr. Robert Pollok. The amount in question is given for the endowment of a university lectureship for original research in materia medica.

MANCHESTER.—The new chemical laboratories (to be known as the John Morley Chemical Laboratories, after the Chancellor of the University) were opened on Monday last by Sir Henry Roscoe, F.R.S., professor emeritus of chemistry in the University.

OXFORD.—It is proposed to confer the degree of D.C.L., *honoris causa*, upon his Excellency Osman Hamdy Bey, director-general of the Imperial Ottoman Museum of Antiquities, Constantinople.

Mr. John Finnigan has been appointed secretary to the Senate of Queen's University, Belfast.

THE new laboratories for physiology, chemistry, and physics of the London Hospital Medical College are to be opened on Friday of next week by Prof. W. Osler, F.R.S., who will afterwards deliver the Schorstein lecture.

COURSES of lectures on the fermentation industries are announced for delivery at the Sir John Cass Technical Institute, Aldgate. The inaugural lecture (on chemistry in relation to brewing and malting) was given by Mr. A. R. Ling on Tuesday last.

MR. H. A. S. WORTLEY, of Downing College, Cambridge, has been appointed assistant lecturer in the day training department of the University College of North Wales, Bangor. The inaugural lecture of the present session was delivered on Tuesday last by Prof. W. M. Flinders Petrie, F.R.S., who spoke on recent excavations in Egypt.

A COURSE of ten lectures on economics, by Mr. Alfred Milnes, has been arranged for delivery at Bedford College for Women in connection with the course of scientific instruction in hygiene at the institution. The lectures are specially designed for women preparing to be factory inspectors or desiring to take part in other public work. They will be delivered on Mondays, beginning on October 11.

THE new chemical laboratory of the Pharmaceutical Society's School of Pharmacy was opened on Wednesday of last week. On the same day began the new session of the school, when the opening address was delivered by Prof. Alexander Tschirch, of the University of Bern, who took as his subject "The Future of Pharmacognosy." At the conclusion of the address the Hanbury gold medal was presented to Prof. Tschirch.

THE Leathersellers' Technical College, which has been erected at a cost of nearly 20,000*l.* in the Tower Bridge Road, was opened by the Lord Mayor of London on Friday last. In declaring the college open, Sir G. Wyatt Truscott said that no subject was of greater interest than the development of technical education and the splendid part which the city guilds had played in that development. The city companies had found, in assisting technical education, an opportunity of re-associating themselves with the interests of the trades that they represented. In the leather trade, unfortunately, the system of apprenticeship had somewhat died out, but he hoped that it might be revived.

IN opening a new wing of the Leicester Technical and Art Schools on Thursday last, Prof. Silvanus P. Thompson, F.R.S., said the conclusion he came to after a tour of the industrial centres of Europe was that the most successful technical schools were those which carefully studied the needs of their own special industries. The disastrous tale of the manufacture of dyes from coal-tar products was not without its warning to this country. The trained brains sent out by German universities and technical colleges profited by the inventions of English chemists, and we paid 2,000,000*l.* a year for dyes manufactured abroad from coal-tar products. Thanks largely to technical education, a similar disaster was averted when the electrical engineering industry was developed.

ACCORDING to a note in the *Engineer*, arrangements have been made with several of the leading engineering firms in Glasgow and elsewhere by which students of the South-western Polytechnic Institute are allowed to enter their apprenticeship. Students who satisfactorily perform the work in the mechanical engineering department in the first year may proceed at once and continue their work at one of the firms arranged for, and students who have satisfactorily finished the second-year course are allowed to proceed with their apprenticeship and return to the college and continue their third session. Furthermore, students who obtain the diploma of their college will have their apprenticeship reduced. Under these conditions a student can obtain a first-class training as an engineer, and apprentices who perform satisfactorily in the workshop are allowed to enter the drawing-office.

ATTENTION has often been directed in these columns to the complete equipment and excellent arrangements of the London polytechnics. Among these institutions, the Batter-